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(54) **Blood culture apparatus having a bell-shaped drum**

(57) The present invention describes an automated blood culture apparatus having a bell-shaped hollow rotatable drum for holding a number of blood culture bottles. All bottles are interrogated by sensor stations located within the drum with the whole system having only one moving part, and no flexible electric or optic cables. Consequently, the expected reliability is high, and the production cost should be low. The apparatus also includes an "auto-unloading" and sorting mechanism for sorting final "negative" and "positive" bottles.

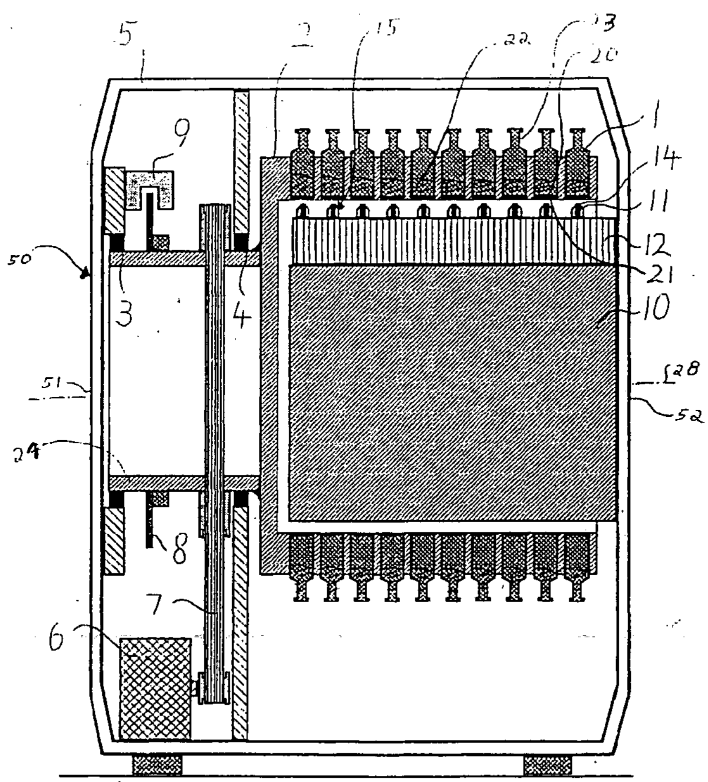

FIG. 1

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precision that is required. Consequently, there is still a need for a mechanically simple blood culture apparatus in which the bottles can be grasped by their necks during loading and unloading or, more importantly, an apparatus that can perform "auto-unloading" and sorting of final negative and final positive bottles.

SUMMARY OF THE INVENTION

The present invention overcomes the above problems by providing a blood culture apparatus for detecting biologically active agents in a large number of blood culture bottles, that is simple and can be produced at very low cost, provides low system sensitivity variations from one bottle station to the next, does not require electronic or optoelectronic components, electrical wires, or optical fibers on the moving bottle rack, has high long-time reliability, allows a user to grasp the bottles at their neck during loading and unloading, offers simultaneous access to a large number of bottles during loading and unloading, and has a smaller footprint as compared to existing blood culture systems.

According to the present invention, the above objectives are achieved by introducing a culture medium and the blood specimen into sealable glass bottles having optical sensing means on their inner bottom surface and by arranging a large number of such bottles radially on a rotating hollow bell-shaped drum within an incubator in such a way that their bottoms are oriented towards the drum axis. The bell-shaped drum is supported only on one end with sensor stations within the drum mounted to the instrument mainframe at such a distance inside the bell-shaped drum that, during rotation of the drum, individual bottles pass by these sensor stations.

In a preferred embodiment of the invention, the axis of the bell-shaped drum is oriented horizontally and parallel to a door on the front face of the incubator. Horizontal orientation of the axis provides maximum agitation of the liquid culture medium, blood specimen, and gas within each blood culture bottle. During the load/unload operation, the door is opened to allow simultaneous access to approximately one third of the bottles. Then, the drum is rotated until the next third of the bottles becomes accessible. Therefore, all bottles are accessible in three steps.

In another option of the current invention, the axis of the bell-shaped drum is oriented vertically with a slight tilting of approximately 20 degrees away from the door. By adjusting the tilting angle, the degree of agitation can be modified, if required.

Still another embodiment is a blood culture apparatus having an "auto-unloading" and sorting feature, wherein final negative and final positive bottles are ejected from the drum and sorted into a "negative" drawer or a "positive" drawer.

These and other aspects, features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a front-view of the interior of a blood culture apparatus for the detection of microorganisms according to the present invention;

Fig. 2 shows a side-view of the interior of a blood culture apparatus according to the present invention;

Fig. 3 shows a front-view of a blood culture apparatus according to the present invention, with the door closed;

Fig. 4 shows a front-view of the blood culture apparatus according to the present invention with the front door open;

Fig. 5 shows a side-view of the interior of an alternative blood culture apparatus; and

Fig. 6 shows a front view of the interior of the alternative blood culture apparatus shown in Fig. 5.

DETAILED DESCRIPTION

According to the present invention, a culture medium and blood specimen mixture 22 are introduced into sealable glass bottles 1 that include optical chemical sensing means 20 on their inner bottom surface 21. Optical chemical sensing means 20 emanates differing quantities of light depending upon the amount of a gas in bottle 1. For example, the gas being detected by optical sensing means 20 can be carbon dioxide, oxygen or any gas that increases or decreases depending upon the presence or absence of microorganism growth in bottle 1.

As illustrated in Figs. 1 and 2, a plurality of such bottles 1 are arranged radially on a rotating bell-shaped drum 2 within an incubator 5 in such a way that the bottoms of bottles 1 are oriented towards a drum axis 28. Bell-shaped drum 2 is hollow and is supported by a shaft 24 rotatably supported on one end by two large ball-bearings 3 and 4 mounted to a first side 51 of an instrument mainframe 50. In order to read information coming from each optical chemical

grasp the bottles at their neck 23 during loading and unloading. Also, the apparatus offers simultaneous access to a large number of bottles 1 during loading and unloading.

Figs. 5 and 6 depict an improved alternative apparatus that offers the additional feature of self-unloading negative and positive blood culture bottles 1 into corresponding drawers 33 and 35. This feature reduces the workload for lab personnel, which is becoming an important issue in today's health care environment. Current blood culture systems do not provide such an "auto-unloading" feature.

As shown in the side view in Fig. 5, there is arranged a unit 26 within drum 2. Unit 26 comprises one piston 27 per drum segment that can be moved out of unit 26 by means of activators 38. If moved out of unit 26, piston 27 pushes one blood culture bottle 1 out of drum 2 located on the same radius of drum 2 as piston 27. In the apparatus of Fig. 5, there is arranged a collector 29 that receives bottle 1 and directs it onto a conveyer belt 31. If bottle 1 has been identified by system controller 10 as containing a final negative culture, conveyer belt 31 is activated by system controller 10 to move in a first direction. Then, as shown in Fig. 5, bottle 1 is transported to the right until it falls into "negative" drawer 33 in an area that is covered by a soft material 32 such as rubber foam and finally rolls towards "negative" door 34.

If bottle 1 has been identified by system controller 10 as containing a positive culture, conveyer belt 31 is activated by system controller 10 to move in a second direction. As shown in Fig. 5, bottle 1 is then transported to the left and falls into a "positive" drawer 35 to roll towards "positive" door 36.

For automatic unloading of final negative and positive blood culture bottles, drum 2 is stopped by control system 10 in a first appropriate orientation, and the corresponding final negative or positive bottle is ejected from drum 2. Then, control system 10 will rotate drum 2 to the next appropriate orientation, and the same procedure is repeated. This process is continued until all final negative bottles and all positive bottles are unloaded into the two drawers 33 and 35. Therefore, control system 10 can be programmed so that at the beginning of a workshift all final negatives are unloaded so that new bottles can be entered and all positive bottles are waiting in drawer 35 for further biological and/or chemical tests.

Fig. 6 is a front view of the apparatus that clearly shows brackets 37 and 39 inside bell-shaped drum 2 mounted to both ends of the instrument's mainframe 50. These two brackets 37 and 39 are used as stable platforms for linear sensor array 12 and unit 26 with its pistons 27 and activators 38. Of course, collector 29 can either be one single unit as shown in Fig. 6 or can be composed of individual collectors for each drum segment.

In the foregoing discussion, it is to be understood that the above-described embodiments of the present invention are simply illustrative of various features of a blood culture apparatus. Other suitable variations, modifications and combinations of these features could be made to or used in these embodiments and still remain within the scope of the present invention.

Claims

1. A blood culture apparatus comprising:

   a housing;
   a plurality of bottles having a bottom and a neck and containing a culture medium, specimen mixture, a head-space gas and optical sensing means;
   a hollow drum rotatably mounted only to a first side of said housing and having an axis disposed therein, said drum being rotatable about said axis and including a plurality of openings in a top surface for receiving said plurality of bottles;
   a mechanism for rotating said drum about said axis; and
   detecting means in said drum for non-invasively detecting microorganisms within each of said plurality of bottles received within said drum.

2. A blood culture apparatus according to Claim 1, wherein each of said plurality of bottles is inserted into said drum base first so that said neck extends out of said opening.

3. A blood culture apparatus as recited in claim 1, further comprising positioning means for identifying the rotational position of said drum.

4. A blood culture apparatus as recited in claim 3, wherein said positioning means comprises an angular decoder mounted about said axis.

5. A blood culture apparatus as recited in claim 1, wherein said mechanism for rotating said drum comprises:

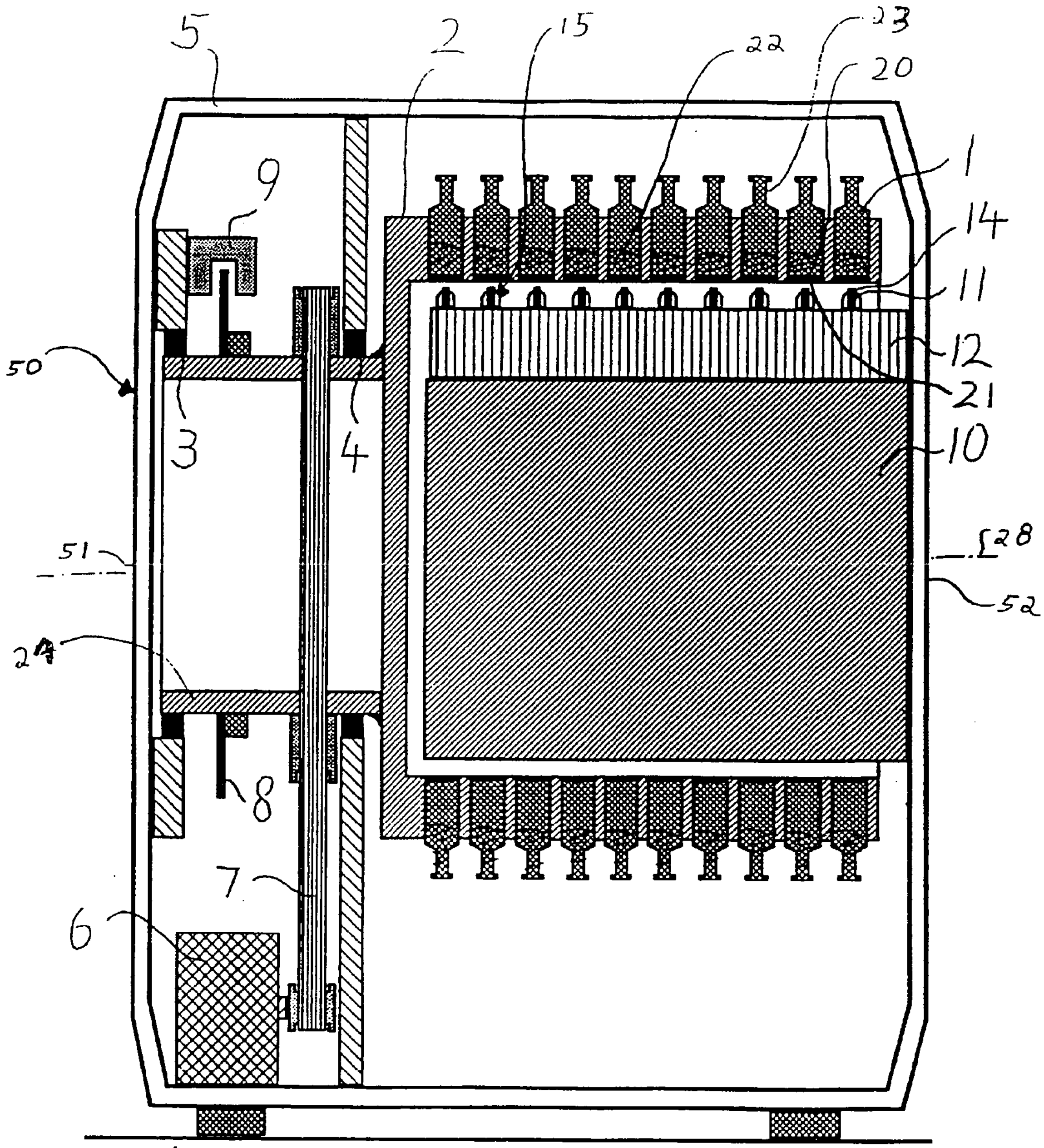

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FIG. 1

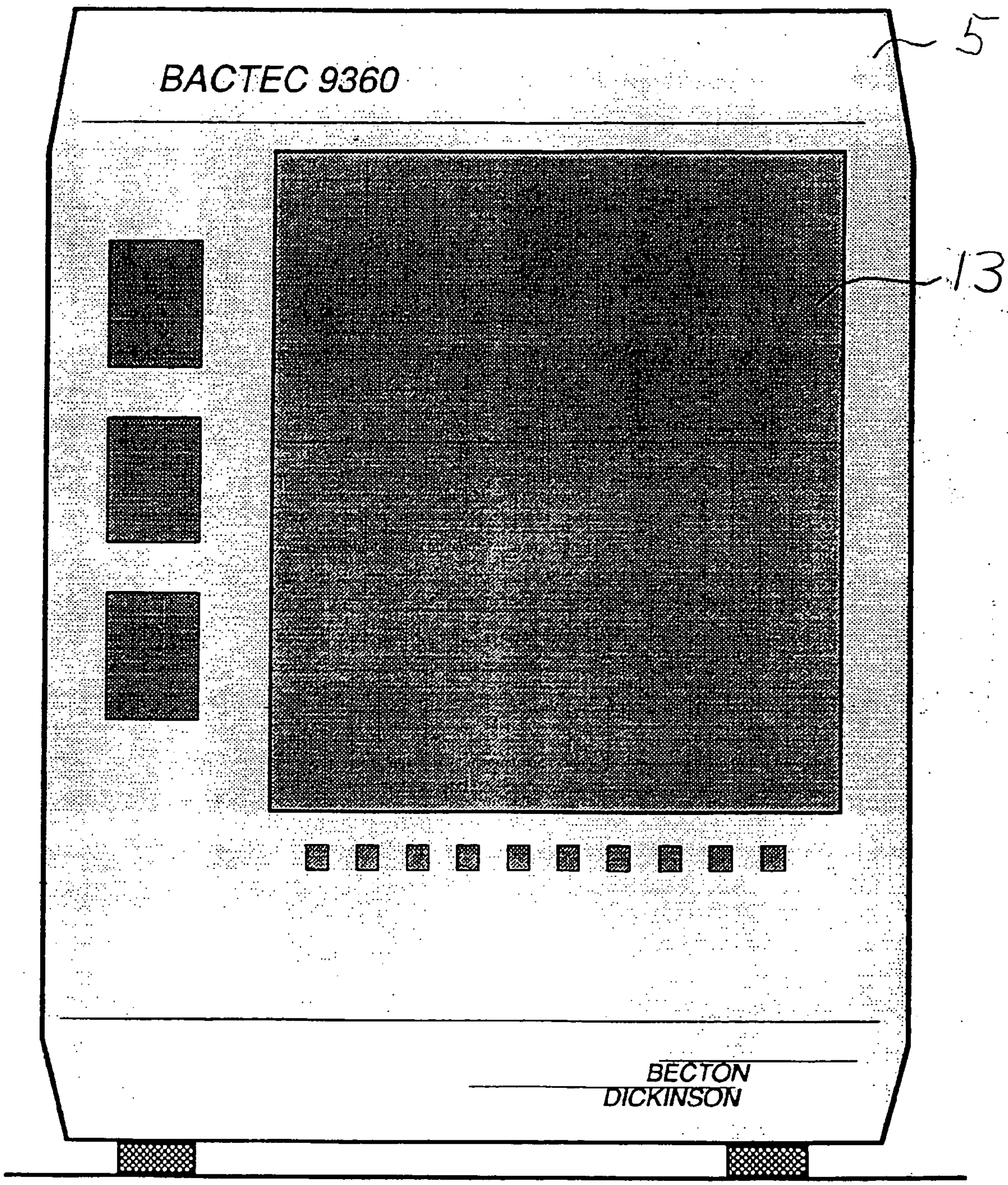
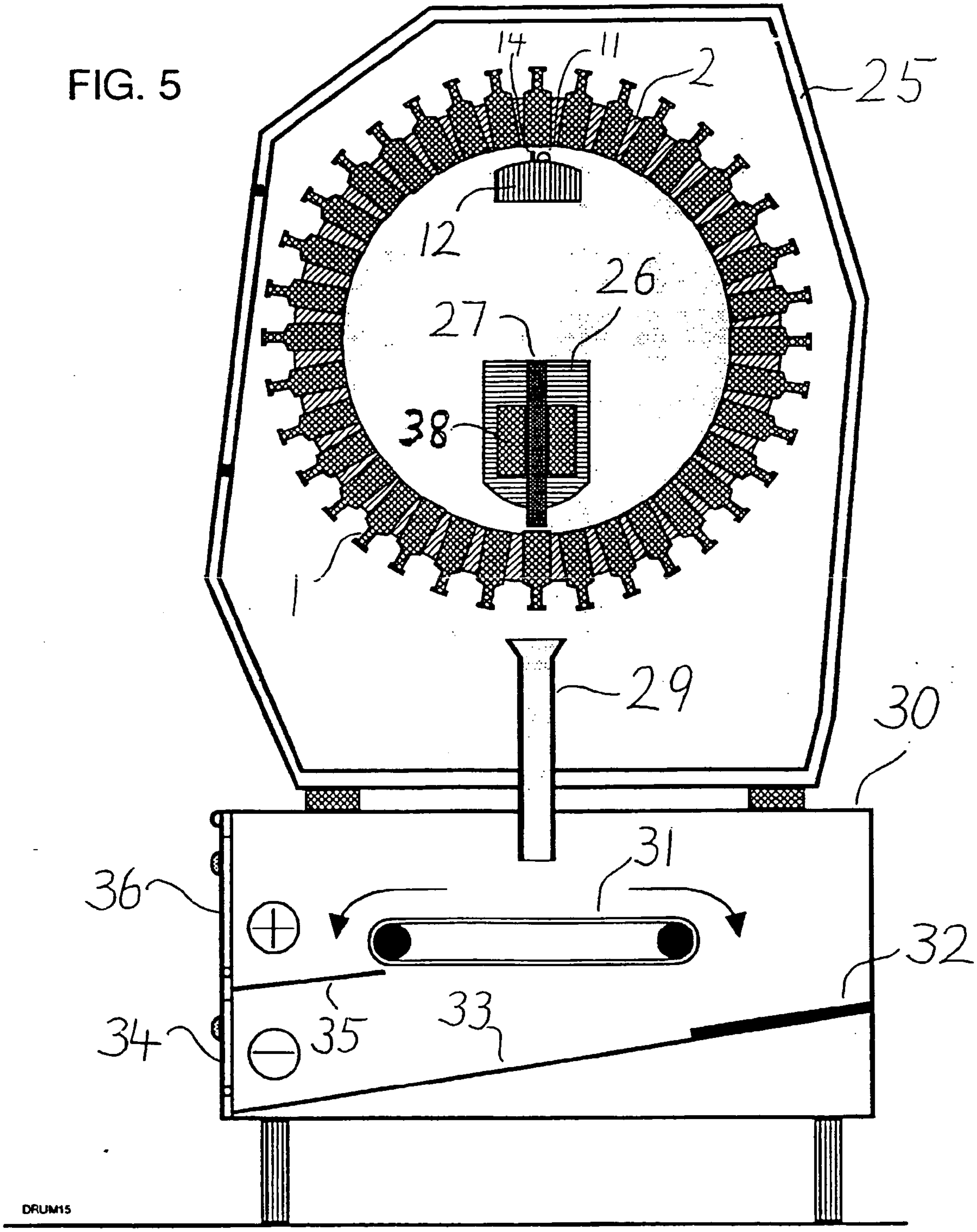


FIG. 3

FIG. 5



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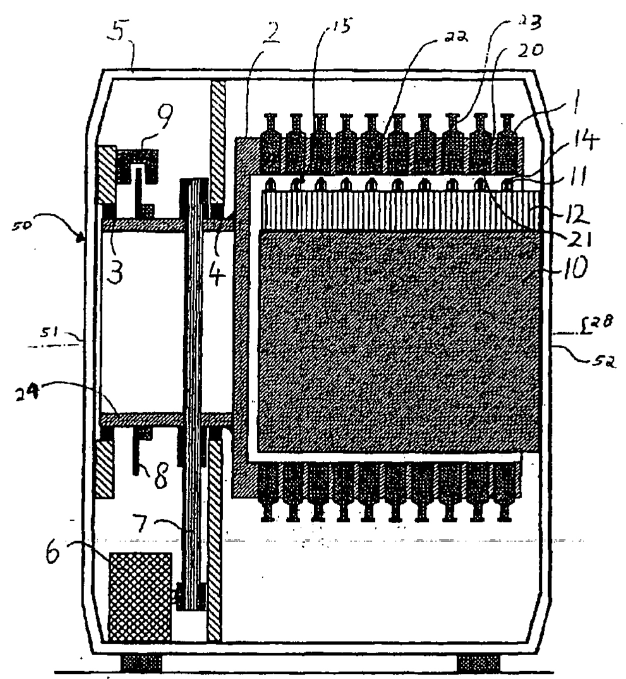

FIG. 1

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 97 30 7155

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